

# G.E.M.S

Gym Equipment Monitoring System

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# Goals

## Project Objective

- Develop an **AI-powered gym equipment monitoring system** that detects when equipment is in use and updates a web interface in real time.
- **Reduce user frustration** by providing live updates on gym equipment availability.
- Improve **gym efficiency** by offering gym owners insights into equipment usage patterns.

## Background & Motivation

- Many gym-goers struggle to find available equipment, leading to **wasted time** and **inefficient workouts**.
- Gym staff **lack real-time data** on which machines are used the most or require maintenance.
- AI-based detection can **automate tracking** without the need for additional staff monitoring.

## Key Features of the System

- **Real-time detection** using machine learning (YOLOv5).
- **Automated status updates** via a MySQL database.
- **Web-based user interface** for gym members to check equipment availability.
- **Data insights** for gym owners on peak usage times

# Intellectual Merits

## Innovative Use of AI in Gym Management

- Integrates **computer vision** and **database management** to create a real-time monitoring system.
- Uses **YOLOv5**, a state-of-the-art object detection model, to identify gym equipment usage.

## Unique Contributions & Novelty

- Unlike traditional gym monitoring systems (manual check-ins or RFID tracking), this project provides:
  - **Automated, AI-driven tracking** with minimal human intervention.
  - **Live status updates** on gym equipment through a web platform.
  - **Cooldown logic** to prevent false detections and improve accuracy.

## Advanced Machine Learning & Computer Vision

- Utilizes a **pre-trained YOLOv5 model**, fine-tuned with **custom gym equipment images** for high detection accuracy.
- Implements a **multi-class recognition system**, identifying both equipment and user presence.
- Runs on **CUDA-enabled GPUs** for real-time video processing.

# Intellectual Merits Continued

## Impact on Human-Computer Interaction

- Provides an **intuitive, user-friendly experience** for gym members via a web interface.
- Demonstrates how **AI can seamlessly integrate into public and commercial spaces** to enhance user convenience.

## Scalability & Future Applications

- The system can be adapted for various industries, such as:
  - Corporate Environments
    - i. Conference Rooms, offices, etc. (availability)
  - Entertainment/Recreation
    - i. Amusement Parks (foot traffic)
  - Retail
    - i. Supermarkets (foot traffic)

# Broader Impact

## Impact on Gym Users

- **Live Equipment Status:**
  - Users can check which equipment is occupied during workout and before heading to the gym.
  - Reduces frustration and waiting times.
- **Enhanced Workout Planning:**
  - Helps users plan their workout based on available equipment.
  - Promotes better time management for gym-goers.

## Benefits for Gym Owners & Staff

- **Optimized Equipment Usage:**
  - Data analytics can help gym owners understand peak usage times.
  - Identifies underutilized equipment, allowing for better resource allocation.
- **Maintenance Scheduling:**
  - Equipment usage logs help predict wear and tear, reducing unexpected breakdowns.

# Broader Impact Continued

## Broader Societal Contributions

- **Encouraging Fitness & Healthy Lifestyles:**
  - Streamlining gym accessibility could promote more consistent exercise habits.
  - Reduces frustration that may deter people from working out.
- **Scalability Beyond Gyms:**
  - The detection model can be adapted for other industries:
    - Corporate Environments
      - Conference Rooms, offices, etc. (availability)
    - Entertainment/Recreation
      - Amusement Parks (foot traffic)
    - Retail
      - Supermarkets (foot traffic)

## Technological Advancements

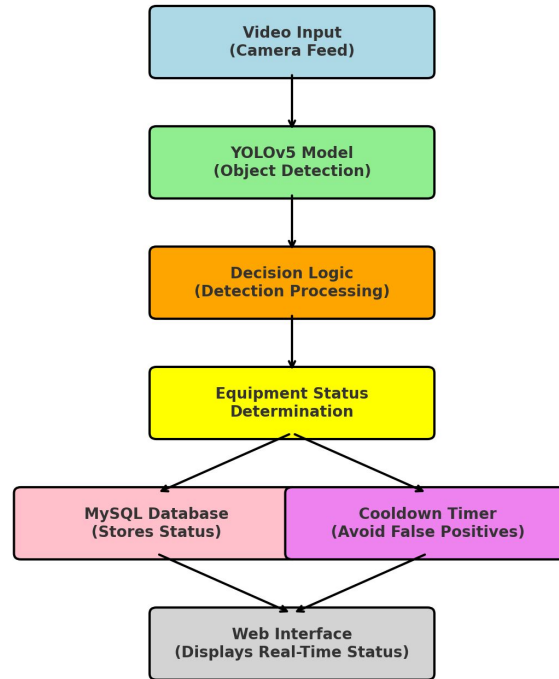
- **Real-Time AI in Everyday Life:**
  - Demonstrates how AI can enhance public and commercial spaces.
- **Data-Driven Decision Making:**
  - Insights from collected data can lead to smarter facility management.

# Design Specifications

- **System Overview:**
  - **Camera Feed** → **YOLOv5 Model** → **SQL Database** → **Web Interface**
- **Design Diagram:**
  - A **flowchart** showcasing data movement between system components on next slide.
- **Implementation Details:**
  - Detection model runs on **CUDA-enabled GPUs** for efficiency.
  - Web UI built with **Flask and SQL** for equipment monitoring.

# Flow Chart

Gym Equipment Usage Detection System Flowchart





## Technologies Used

- **Machine Learning:** YOLOv5 for real-time detection.
- **Database:** MySQL for storing equipment usage data.
- **Backend:** Python (Flask) for processing detections.
- **Frontend:** HTML/CSS for user-friendly interface.
- **Hardware:** Camera setup for real-time monitoring.
- **Detection Software:**
  - Runs the **YOLOv5 model** to detect gym equipment usage.
  - **Automatically updates the database** when equipment status changes (e.g., "in use" → "available").
  - Uses a **cooldown mechanism** to reduce false detections.

# Milestones

Challenge	Solution
False detections due to movement or lighting	Implemented a <b>cooldown timer</b> mechanism to prevent rapid status changes.
Database synchronization issues	Optimized <b>MySQL queries and indexing</b> to ensure real-time updates.
Slow detection speed on CPU	Used <b>GPU acceleration (CUDA)</b> to speed up YOLOv5 inference.
Difficulty in differentiating equipment	Trained YOLOv5 on <b>custom-labeled datasets</b> with diverse gym conditions.
Varying lighting conditions in gyms	Collected <b>dataset images from different lighting environments</b> to improve model robustness.
Web interface delays in displaying updated statuses	Implemented <b>AJAX polling</b> to refresh equipment status dynamically without full page reloads.

# Results Achieved

## YOLOv5 Model Successfully Trained

- The detection model was trained with **custom-labeled images** of gym equipment.
- Achieved **high accuracy** in detecting equipment and user presence.

## Real-Time Detection Implemented

- Integrated **YOLOv5 with OpenCV** to process live camera feeds.
- Detection system runs **efficiently on CUDA-enabled GPUs** for faster inference.

## Database Integration Completed

- MySQL database **stores and updates equipment status** dynamically.
- Detection results are automatically **logged and updated** in real time.

# Results Achieved Continued

## Web Interface Development - In Progress

- Basic **HTML/CSS layout created**, connected to the backend.
- Need to refine **UI design and AJAX polling** for real-time status updates.
- Still working on **user accessibility features** for gym members.

## Remaining Tasks:

- Complete **frontend integration** and polish the UI.
- Conduct **full-system testing** to ensure stability.
- Deploy and optimize the final version.

# Challenges & Solutions

Challenge	Solution
False Detections (misidentifying equipment usage)	Implemented a <b>cooldown timer</b> to prevent rapid status changes and reduce false positives.
Database Synchronization Issues	Optimized <b>MySQL queries</b> and added <b>indexed tables</b> for faster updates and retrieval.
Slow Detection Speed on CPU	Moved processing to <b>CUDA-enabled GPUs</b> , significantly improving YOLOv5 inference speed.
Varying Lighting Conditions	Trained the model on <b>diverse lighting environments</b> and applied <b>image preprocessing</b> to enhance consistency.
Data Collection Challenges	Gathered a <b>larger dataset</b> with more variations, including different gym setups and angles, to improve detection.
Accuracy of the Model	Fine-tuned YOLOv5 with <b>custom-labeled data</b> and used <b>data augmentation techniques</b> to enhance performance.